Appendix M

Report on *Toxoplasma Gondii*: Its Sources and Impacts on Sea Otters, and What Municipalities Can Do to Help Reduce or Eliminate These Impacts

Toxoplasma Gondii: Its Sources and Impacts on Sea Otters, and What Municipalities Can Do to Help Reduce or Eliminate These Impacts

BMP 2-2.d of the Monterey Regional Storm Water Management Program (MRSWMP) establishes the following Implementation Plan:

> *"Based on existing scientific studies and data, the MRSWMP Group will implement a pollution reduction component that identifies with specificity the geographic areas within the jurisdiction of each municipality that are sources of pollution, including T. Gondii and other pathogens, impacting California sea otters. Once the geographic areas are identified, the MRSWMP group will create and implement a program to reduce and eliminate the sources of pollution identified as impacting sea otters."*

The following Measurable Goals are established in the MRSWMP for this BMP:

> *"Year 1: Based on existing scientific studies and data identify with specificity the geographic areas within the jurisdiction of each municipality that are sources of pollution, including T. Gondii, and other pathogens, impacting California sea otters and results included in the Annual Report;*
> *Year 2: Create and implement a program to reduce and eliminate the sources of pollution identified as impacting sea otters. The program and implementation will be described in the Annual Report."*

This report is prepared in fulfillment of the Year 1 Measurable Goal, and to describe the program that will be used to fulfill the Year 2 Measurable Goal.

The report contains information about T. Gondii (*Toxoplasma gondii)* derived from a review of nearly twenty technical papers and other current information sources on the subject of sea otter mortality caused by this parasite, as well as interviews with several experts in the field including the executive director of the Monterey Bay office of "The Otter Project" an organization dedicated to the preservation of sea otters.

What is *Toxoplasma Gondii*?

The protozoa parasite *Toxoplasma gondii* is a recognized pathogen of humans and terrestrial animals. This parasite has a two-host lifecycle, with many animals, including mice, birds, domestic livestock and humans serving as potential intermediate hosts.

Toxoplasma gondii is a genus of parasitic protozoa whose definitive host is cats but which can be carried by the vast majority of warm-blooded animals, including humans. Toxoplasmosis, the disease it causes, is usually minor and self-limiting but can have serious or even fatal effects on a fetus whose mother first contracts the disease during pregnancy or on immunocompromised human or cat. It belongs to the phylum Apicomplexa, and *Toxoplasma gondii* is the only know member species of the genus *Toxoplasma*.

The life cycle of *Toxoplasma gondii* has two phases. The sexual part of a lifecycle takes place only in members of the Felidae family (domestic and wild cats), which makes these animals the parasite's primary host. The asexual part of the lifecycle can take place in any warm-blooded animal, like other mammals (including felines) and birds.

In these intermediate hosts, the parasite invades cells, forming intracellular so-called parasitophorous vacuoles containing bradyzoites, the slowly replicating form of the parasite. Vacuoles form tissue cysts mainly within the muscles and brain. Since they are within cells, the host's immune system does not detect these cysts. Resistance to antibiotics varies, but the cysts are very difficult to eradicate entirely. Within these vacuoles *Toxoplasma gondii* propagates by a series of binary fissions until the infected cell eventually bursts and tachyzoites are released. Tachyzoites are the motile, asexually reproducing form of the parasite. Unlike the bradyzoites, the free tachyzoites are usually efficiently cleared by the host's immune response, although some manage to infect cells and form bradyzoites, thus maintaining the infection.

Tissue cysts are ingested by a cat (e.g., by feeding on an infected mouse). These cysts survive passage through the stomach of the cat, and the parasites infect epithelial cells of the small intestine where they undergo sexual reproduction and oocyst formation. Oocysts are shed with the feces. Animals and humans that ingest oocysts (e.g. by eating unwashed vegetables etc.) or tissue cysts in improperly cooked meat become infected. The parasite enters macrophages in the intestinal lining and is distributed via the bloodstream throughout the body.

Acute stage toxoplasma infections can be asymptomatic, but often gives flu-like symptoms in the early acute stages, and like flu can become, in very rare cases, fatal. The acute stage fades in a few days to months, leading to the latent stage. Latent infection is normally asymptomatic; however, in the case in immunocompromised patients (such as those infected with HIV or transplant recipients on immunosuppressive therapy), toxoplasmosis can develop. The most notable manifestation of toxoplasmosis in immunocompromised patients is toxoplasmic encephalitis, which can be deadly. If infection with *Toxoplasma gondii* occurs for the first time during pregnancy, the parasite can cross the placenta, possibly leading to hydrocephalus, intracranial calcification, and chorioretinitis, with the possibility of spontaneous abortion or intrauterine death.

A study conducted in 2004 – 2005 found that approximately 33% of U.S. persons above 12 years

of age had *Toxoplasma gondii*-specific antibodies, indicating that they had been infected with the organism. This was a slight increase from similar data collected approximately four years earlier.

There is another parasite which can also cause fatal brain infections in sea otters, and this is the parasite *Sarcocystis neurona*. The environmentally resistant egg-like stage of this parasite is shed by possums, but as far as is currently known is not shed by cats. The parasite may be carried via freshwater into the ocean where sea otters are exposed. Research into this parasite and its impacts on sea otters is in its infancy in the Monterey Bay area.

What are the Medical Implications of *Toxoplasma Gondii*?

To Humans: The most common routes of *Toxoplasma gondii* infection for humans are through exposure to oocysts in contaminated soil, transplacental transmission, or by consumption of uncooked or undercooked meat containing encysted parasites.

The parasite is usually harmless to healthy people. The exception is pregnant women, whose fetuses can develop *Toxoplasma gondii*, hence the advice for pregnant women to avoid cleaning cat litter boxes.

To Other Land-dwelling Animals: This parasite has a two-host lifecycle, with many animals, including mice, birds, domestic livestock and humans serving as potential intermediate hosts. In the intermediate host, invasive stages of *Toxoplasma gondii* may spread throughout the muscles, nervous system, and other tissues, forming long-lived tissue cysts. Theses cysts typically do not harm the animal.

The only animals known to shed oocysts in their feces are felines, most importantly domestic cats. These oocyst-shedding definitive hosts are infected through oocyst exposure, or by consumption of infected intermediate hosts. Cats typically shed oocysts within 3-10 days after becoming infected, either through consumption of tissue cysts or from sporulated oocysts from other cats, and may continue to shed oocysts for up to 20 days. The first time cats are infected they can shed more than 100 million oocysts in their feces.

To Marine Mammals, and in Particular Sea Otters: Recent evidence indicates that waterborne *Toxoplasma gondii* exposure is more common then previously recognized. These waterborne infections probably result from exposure to infective oocysts in polluted water, but it is also possible that aquatic species may serve as intermediate or paratenic hosts.

Increasing recognition of *Toxoplasma gondii* infection in diverse species of marine animals provides compelling evidence for marine dispersal of this terrestrial pathogen. The recent recognition of numerous fatal *Toxoplasma gondii* brain infections in southern sea otters from California has prompted concerns about the emergence of *Toxoplasma gondii* as a significant marine pathogen.

One recent study found that 36 % of freshly dead sea otters in the central California coastal area

were infected with *Toxoplasma gondii*, suggesting that *Toxoplasma gondii* infection is common in southern sea otters. The exact role of *Toxoplasma gondii* as a principal cause of mortality in sea otters has not been established, but is under investigation.

The parasite attacks an otter's brain tissue, causing lesions, tremors, depression, seizures, convulsions and death.

What is Known About the Impact of *Toxoplasma Gondii* on Sea Otters Along the Central California Coast?

Data collected between 1997 and 2001 on over 220 live and dead-sampled southern sea otters between Santa Barbara and Half Moon Bay resulted in the following findings:

- In 2002 the California sea otter population was estimated to be approximately 2,300 animals.

- 42% of the live sea otters had antibodies to *Toxoplasma gondii* present in their bodies, and 62% of the dead sea otters had the antibodies present. In a more recent although smaller study, reported on in 2003, these percentages were found to be 60% and 77%, respectively. The presence of these antibodies indicates that the animal was infected with the parasite. It should be noted that the studies differ in their methodology, and therefore trends cannot be inferred from them.

- Male sea otters were almost twice as likely as females to be infected with *Toxoplasma gondii*. Males are more likely to travel long distances in their efforts to establish and defend territories. If *Toxoplasma gondii* contamination of the near shore marine environment occurs as multiple areas of point-source contamination, then wide-ranging males would be more likely to come into contact with one or more of these contaminated areas during their lifetimes.

- There appears to be no correlation between the nutritional condition of the sea otter and the incidence of infections with *Toxoplasma gondii*.

- There did not appear to be any significant association between sea otter infections by *Toxoplasma gondii* and the proximity of the sea otters to areas of high human population density.

- There did not appear to be any significant association between sea otter infections by *Toxoplasma gondii* and the proximity of the sea otters to outfalls from wastewater treatment plants. However, it should be noted that wastewater outfalls typically discharge a significant distance offshore, while sea otters typically inhabit the near coastal areas. Thus, there may be little direct contact by sea otters with wastewater treatment plant discharges.

- There was a high correlation between *Toxoplasma gondii* infections in sea otters and the proximity of the sea otters to freshwater flows (streams, rivers, storm drainage outfalls) discharging to the marine environment. Otters located at sites where large freshwater flows

occurred were nearly three times more likely to be infected with *Toxoplasma gondii* than those sampled at low flow sites.

- A large colony of *Toxoplasma gondii* infected sea otters was found within a 20 km coastal region centered on the towns of Morro Bay and Cayucas, California. Otters sampled from this area were nearly twice as likely to be infected with *Toxoplasma gondii* than for all otters combined.

- For otters sampled within Monterey Bay, a second colony of *Toxoplasma gondii* infected sea otters was detected within a 27 km region centered on Elkhorn Slough and Moss Landing. Nearly 79% of the otters sampled within this region showed evidence of infection with *Toxoplasma gondii* and otters sampled within 10 km of Elkhorn Slough were 1.5 times more likely to be infected than for all otters combined.

- A region of low *Toxoplasma gondii* infection was detected for otters sampled within a 28 km region encompassing the tip and southern portion of the Monterey Peninsula. Otters sampled within this region were half as likely to show evidence of infection than for all otters combined.

One researcher reported that toxoplasmosis is responsible for 17% of otter deaths along the California coast, and renders other otters more vulnerable to shark attack. Although this speculation may be correct, at this point there does not appear to be any scientific finding that would support the conclusion that otters with *T. Gondii* are more susceptible to shark attack.

What Are the Likely Means of Transmitting Toxoplasma Gondii from Land to the Coastal Marine Environment?

Research is ongoing in an effort to more fully understand the mechanisms and factors that lead to *Toxoplasma gondii*- caused mortality in sea otters. It is known that numerous factors and stresses can contribute to sea otter deaths. These include exposure to other diseases, environmental conditions, chemical contaminants, nutritional condition of the sea otters, accidents and injuries, and attacks by sharks.

Cats are the only known hosts that can excrete environmentally resistant oocysts. Cats can excrete millions of oocysts, and there are more than 100 million cats estimated to be living in the United States.

Surface runoff from urbanized areas typically includes runoff from landscaping, lawns, streets, and other areas where cat feces may be present. Environmentally resistant *Toxoplasma gondii* oocysts in cat feces could be transported to the near shore marine environment by surface runoff.

Therefore, otters living near large plumes of contaminated freshwater are theorized to be at increased risk for *Toxoplasma gondii* exposure.

No definitive research work has been completed to determine whether or not cat litter that is flushed into the sanitary sewer system by pet owners, and then passes through wastewater treatment plants, results in the discharge of *Toxoplasma gondii* to the marine environment. However, it is theorized that conventional wastewater treatment processes (primary and secondary treatment with disinfection for most marine discharges) may not kill protozoan oocysts, and may even enhance their infectivity through aeration in the treatment processes.

One potential pathway that has been ruled out is infection of sea otters from humans. According to the Center for Disease Control and Prevention, more than 60 million people in the United States may be infected with the *Toxoplasma gondii* parasite. Of those who are infected, very few have symptoms because a healthy person's immune system usually keeps the parasite from causing illness. However, humans have never been found to shed viable oocysts in their feces. Therefore, it would not be possible for humans to be directly contributing to the infection of sea otters with this parasite.

What Are the Likely Means by Which Sea Otters Have Become Infected with Toxoplasma Gondii?

The mechanism of *Toxoplasma gondii* infection in marine mammals is not well understood. Most of these feed on fish or invertebrates, cold-blooded animals, or they are exclusively herbivorous. Thus ingestion of meat that is infected with *Toxoplasma gondii* is unlikely.

Toxoplasma gondii is not known to parasitize any cold-blooded animals. However, mollusks and many ocean organisms can filter large quantities of water and may concentrate microbes from the water. Concentration of oocysts by mollusks has been experimentally demonstrated under laboratory conditions, although it has not been proven in the field.

Interestingly, a study found that 100% of the wild Atlantic bottlenose dolphins sampled in the Sarasota area in Florida were infected with *Toxoplasma gondii.* Many marine mammals have been found to be infected, leading to speculation that filter feeders my initially trap the oocysts.

The marine source of *Toxoplasma gondii* exposure for sea otters is not presently known. However, it is known that *Toxoplasma gondii* oocysts are extremely resistant to environmental influences. They are therefore presumed to be able to survive in the sea for long periods of time, although studies to confirm this have not yet been performed. Tests have been performed, however, showing that *Toxoplasma gondii* oocysts have remained viable in water for 54 months at a temperature of 4^{o} C, and can survive in the soil for over a year.

One possible route of sea otter contamination is through direct ingestion of infective oocysts present in contaminated water. This could occur through drinking and/or through the grooming of their fur.

Another possible route is through infective oocysts that have been concentrated and transmitted to sea otters through filter-feeding activity of benthic invertebrates, as has been demonstrated previously for related pathogenic protozoa. Filter-feeding benthic invertebrates, such as clams and mussels, are a common prey source for southern sea otters. Sea otters feed almost

exclusively in the near shore marine environment and consume approximately 25% of their body weight each day in filter-feeding benthic invertebrates and other prey.

Recent research suggests that the most likely route of infection is through the consumption of these invertebrates. (Since humans consume the same or similar invertebrate species, including clams and mussels, if further research confirms *Toxoplasma gondii* contamination in near shore benthic invertebrates, this would have significant human health implications.)

Have Specific Geographic Areas that are the Sources of Pathogen Pollution Impacting Sea Otters Within the Jurisdiction of Each Municipality Been Identified?

The direct answer to this question is "no." However, contacts were made with Brian Hatfield of the United States Geological Survey (USGS) Biological Resources Division, and with Melissa Miller of the State of California Department of Fish and Game, to learn about the statewide database of sea otter strandings. The purpose of these contacts was to see if the database might be useful in identifying any correlations between the incidence of strandings and the locations of storm water outfalls within the MRSWMP area. The following was learned through these contacts:

- A statewide database of sea otter strandings has been kept since the late 1980s. The early data is in hard copy form, while the more recent data is kept in electronic form as well. Mr. Hatfield will forward to the MRSWMP group a copy of the data from recent years for the coastline located within the MRSWMP area.
- The database lists all strandings, without distinguishing those where T. Gondii appeared to be the cause of the stranding.
- Dr. Miller performs necropsies on the sea otters and is thus able to identify those strandings that appear to be caused by T. Gondii. She annotates that information on her copy of the database. Dr. Miller will forward to the MRSWMP group a copy of the data from recent years for the coastline located within the MRSWMP area.
- The database uses a plot of the 30-foot depth contour along the entire length of the California coastline. This plot uses geographic increments of 0.5 kilometer along its length as the basis for geographically locating each stranding.
- Mr. Hatfield stressed that stranded animals are for the most part found on beaches, rather than at sea, and may have drifted long distances before ending up on the beach. He also noted that certain beach areas would be more likely to have stranded otters wash up on them, due to such factors as beach slope, currents, and other oceanographic characteristics. Therefore, a high incidence of strandings in a given beach area might or might not be the result of that beach being close to the location of the cause of the stranding.

Research into the issue of *Toxoplasma gondii* infection in sea otters is in its early stages. Much of the work to date has been done simply to determine whether or not this parasite is present in sea otters, and to what extent the parasite has caused, or contributed to, sea otter mortality. Very little work has been done to date to attempt to specifically determine the sources of pathogen pollution impacting sea otters, or to identify where these sources are located. However, the

research to date strongly suggests that areas where cat feces are deposited on the land in ways or locations where these feces can find their way to the marine environment are likely to be the sources of such pollution. These would include essentially all of the urbanized areas covered by the MRSWMP.

As described in a preceding section, there are areas of both higher and lower levels of sea otter infection with the *Toxoplasma gondii* parasite. Within the MRSWMP area the highest levels of infection were found to be in the Elkhorn Slough and Moss Landing area. The research suggests that this may be due to a large freshwater discharge that occurs in this area, and which presumably serves as a source of *Toxoplasma gondii* contaminated water from the upstream watershed. A region of low *Toxoplasma gondii* infection was found to exist within an area encompassing the tip and southern portion of the Monterey Peninsula. The research suggests that this may be due, at least in part, to the lack of any large freshwater discharge in this area.

However, the research discussed in the preceding paragraph apparently did not take into account such factors as the influence of Monterey being a harbor, nor did it compare data from urban vs. rural areas. Since there is likely a long list of factors correlated with disease, it would not be prudent at this point to conclude that presence or absence of freshwater discharges directly impact the incidence of infection with T. Gondii.

With Respect to Municipal Separate Small Storm Water Systems (MS4s) What Are Potential Ways of Reducing the Discharge of Toxoplasma Gondii Parasites to the Coastal Marine Environment?

From the information discussed above, it is apparent that the most logical cause of *Toxoplasma gondii* being found in the coastal marine environment is from cat feces being washed into the ocean. Research and education to inform the public of scientific findings will be required to reduce the risk of *Toxoplasma gondii* exposure. Any approach to reducing the discharge of *Toxoplasma gondii* parasites to the marine environment will need to be directed at preventing cat feces from being deposited on the land and/or discharged to that environment.

The following is a list of potential ways of achieving this objective:

1. Keeping domestic (owned) cats from defecating outdoors, i.e. keeping domestic cats indoors:

In the United States the size of the owned-cat population has grown over 80% in the past decade. It is estimated that 32% of households in the United States own cats, and estimates of the owned-cat population are greater than 78 million. The size of the feral cat population is unknown, but is estimated to be close to 73 million. The wild felid populations are comparatively small, with only 30,000 cougars estimated to exist in the United States, with an estimated 5,100 of these in California. Surveys conducted on domestic cats indicate that from 8% to 74% of cats in the United States are infected with *Toxoplasma gondii,* and up to 2% of these cats may be shedding oocysts at any time.

In all but a few communities in California (as in most areas globally), owned cats are not required to be licensed. Many domestic cats have extensive outdoor access which allows them to

prey on wild rodents and birds that may be infected with *Toxoplasma gondii*, as well as defecate in any convenient location.

A survey was performed in 2006 by several research institutes to estimate the size of cat populations, cat management practices, and outside fecal deposition by cats. The study also evaluated the attitudes of cat owners and non-owners to stray animal control, water pollution, and wildlife protection. The survey was conducted by telephone across a sample population of 294 residents of Cayucos, Los Osos, and Morro Bay, California. Findings and conclusions of the study were as follows:

- The region's cat population was estimated to be 7,284 owned and 2,046 feral cats
- 38% of surveyed households housed a mean of 1.9 cats per household
- 44% of cats defecated outside more than 75% of the time
- Annual fecal deposition (wet weight) in the three communities was estimated to be 76.4 tons
- Cat owners were more likely to oppose cat licensing and impounding stray cats, and to support trap-neuter-return for stray cats, and less likely to be concerned about water pollution, than were non-cat owners
- Feral cats represented a sizable population (22 %) of the free roaming cats in this area and were estimated to be contributing 29.5 tons of feces to the environment per year; this would constitute 28% of the annual outdoor fecal deposition
- Owned cats, not feral cats, were the principal source of fecal loading to the environment; owned cats defecating outdoors contributed an estimated 76.4 tons or 72% of the annual outdoor fecal deposition

Control of feral cats would be extremely difficult, for a number of reasons:

- Cost and commitment of public resources in the form of animal control officers and housing for captured cats
- Public opposition, particularly from the large population of cat owners
- Likelihood of inadvertently capturing owned cats that are free to roam outdoors

Licensing of cats would not prevent those cats from defecating outdoors. However, it would provide an opportunity to provide educational materials to cat owners regarding the public health and marine environment risks associated with improper disposal of cat feces.

Requiring that owned cats be kept indoors would surely be strongly opposed by cat owners, the majority of which allow their cats to freely roam outdoors. The cost and commitment of public resources in the form of animal control officers to enforce this type of requirement would likely be unacceptable to communities.

In spite of the difficulties described above, trying to reduce the number of free-roaming cats (this term includes both domestic cats that are allowed to roam, as well as feral cats which are undomesticated cats that have either been released into the wild to fend for themselves, or are cats that were born in the wild) should be considered. If efforts to reduce the number of free-roaming cats could be successfully undertaken, it might be a means of reducing the *T. Gondii* exposure to sea otters. There are numerous websites containing information on this subject, and

several of them were reviewed in conjunction with preparing this report. From the websites that were visited it appears that feral cat control approaches that involve trapping feral cats and either neutering and releasing them back into the environment, or in some instances euthanizing them, are the "control" approaches in use in various parts of the U.S. The websites claim that this approach reduces the number of feral cats and also eliminates some of their habits which are objectionable to the human population. While this approach may reduce and help to stabilize the feral cat population, the websites did not claim that this approach would eliminate the feral cat population. From the data that was presented on the websites, it was difficult to determine how significant this approach would be on reducing the feral cat population. Therefore, the effectiveness of this approach in terms of its impact on the *T. Gondii* issues pertaining to sea otters is unknown. In the Monterey County area the "Animal Friends Rescue Project" a non-profit animal rescue organization supports the trap-neuter-release approach with literature, traps, and instructions on how to trap and release feral cats, after they have been neutered by a veterinarian. In Santa Cruz County there is a similar program under the auspices of "Project Purr" a non-profit cat rescue organization.

2. Removing cat feces that are deposited outdoors and disposing of it properly to landfills, so it cannot be discharged to the marine environment via runoff.

This approach could be used with potential benefit, and could be a combined effort of residents and public works personnel. Residents could be educated about the public health and marine environment risks posed by the transmission of cat feces through storm water and landscape irrigation runoff. These residents could be urged to regularly examine gardens and other areas on their property where free roaming cats are likely to defecate, and to pick up and properly dispose of cat feces they find on their property. Public works personnel that routinely perform cleaning and maintenance of parks and greenbelt areas within communities could be similarly educated.

This approach would not have a large impact on the transmission of feces from feral cats to the marine environment, because feral cats deposit feces in undeveloped areas that would likely not be visited by either residents or public works personnel. However, if the findings of the 2006 survey reported above are representative of the area covered by the MRSWMP, the majority of the cat feces deposition occurs from owned cats. Thus this approach has the potential to reduce a good portion of the feces that currently is presumed to be flushed into the marine environment.

3. Dispose of cat litter and cat feces as solid waste to a landfill, not to toilets flowing into the sanitary sewer system

Some brands of cat litter are now marketed as "ecologically friendly" and suitable for composting or flushing down the toilet. Oocysts may survive up to 18 months in soil under favorable conditions, and wastewater treatment practices are not designed to destroy the highly resistant oocysts of *Toxoplasma gondii*. No definitive research has been preformed to determine whether or not the *Toxoplasma gondii* parasite passes through wastewater treatment plants and is discharged to the marine environment. Nevertheless, cat owners should be urged to bag and dispose of cat feces and cat litter in approved sanitary landfills where runoff is controlled, rather than flushing it down the toilet.

Recommended Program to Reduce or Eliminate the Sources of *Toxoplasma Gondii* Pollution Identified as Impacting Sea Otters Within the Jurisdictions of the MS4s Covered by the MRSWMP

The recommended program to be implemented beginning in Year 2 is directed at public education, and better identifying the locations of sea otter strandings and their proximities to storm water discharges, as described below.

1. The Public Education and Public Outreach program conducted under Minimum Control Measure No. 1, and the municipal staff training programs under Minimum Control Measure No. 6, will be expanded to provide education about the public health and marine environment risks associated with improper disposal of cat feces. The following would be included within the expanded educational program:

- Urge residents to regularly examine gardens and other areas on their property where free roaming cats are likely to defecate, and to pick up and dispose of cat feces with their solid waste that is sent to the sanitary landfill.
- Direct public works personnel that routinely perform cleaning and maintenance of parks and greenbelt areas within communities to similarly pick up and dispose of fecal material that is found on public property in parks and other areas.
- Urge cat owners to bag and dispose of cat litter and cat feces with their solid waste that is sent to the sanitary landfill, rather than flushing it down the toilet.
- Develop an educational message to the public describing the feral cat implications on storm water pollution and its association with sea otter deaths.
- Distribute educational brochures covering these topics at public events, veterinarian clinics, animal shelters, the SPCAs, and other suitable locations.

2. Investigate the feasibility of assisting organizations within the area covered by the MRSWMP in publicizing or promoting their feral cat control programs.

3. Continue seeking to obtain geographic data on the locations of sea otter strandings associated with *T. Gondii*. If such data can be obtained in a format that can readily be used for mapping, develop a map of the coastline within the MRSWMP area showing the locations of strandings and their proximities to storm water outfalls.

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21. "U.S. Faces Growing Feral Cat Problem," a September 4, 2004 article on the National Geographic website: www.news.nationalgeographic.com.

22. Margaret R. Slater, Community Approaches for Feral Cats, published by the Humane Society Press, c. 2002. (can be downloaded via the Humane Society's website: http://www.hsus.org/press_and_publications/humane_bookshelf/community_approaches_to_feral_cats_problems_alternatives_recommendations/index.html.

23. "The American Cat Project," website sponsored by the American Cat Project of Spencer, New York: www.americancat.net.

24. "Feral Cats," on the website of the Animal Friends Rescue Project website for Monterey County: http://www.animalfriendsrescue.org/feralcats.html.

25. "Regulation of Cats," an article dated June 2007 on the website of the Municipal Research and Services Center of the State of Washington: http://www.muniresearch.net/subjects/pubsafe/animal/cats.aspx.